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AIRCRAFT CHARACTERISTICS FOR AIRFIELD PAVEMENT DESIGN AND EVALUATION

Richard B. Kent, Captain, USAF

TECHNICAL REPORT NO. AFWL-TR-65-206

March 1966

AIR FORCE WEAPONS LABORATORY
Research and Technology Division
Air Force Systems Command
Kirtland Air Force Base
New Mexico

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FOREWORD

The work reported here was accomplished as an in-house effort under Program Element 6.44.15.06.4, Project 4051, Task 01.

This report was submitted by the author 1 March 1966. Inclusive dates of research were March 1965 to February 1966.

The author wishes to acknowledge the contribution of a significant portion of the data by the Launching and Alighting Division, Directorate of Airframe Subsystems Engineering, Systems Engineering Group, Research and Technology Division, AFSC, Wright-Patterson AFB, Ohio, in particular Mr. D. E. Williams of that organization.

This report has been reviewed and is approved.

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ABSTRACT

Aircraft characteristics data are presented for use by civil engineers in the layout, design, and evaluation of airfield pavement systems. Aircraft dimensions, pertinent gross weights and performance data, and landing gear configurations are presented in convenient reference tables.

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ILLUSTRATIONS

TABLES

SECTION I

INTRODUCTION

This report presents, for easy reference, USAF aircraft characteristics required by civil engineers in the layout, design or evaluation of airfield pavement systems.

Regardless of the type of pavement under consideration--rigid, flexible, prefabricated (mat), or bare earth--certain essential data are needed for design or analysis. The reference tables present aircraft dimensions, gross weights, performance data, and landing gear configurations necessary for such design.

It should be emphasized that data extracted from Standard Aircraft Characteristics (Ref. 1) are not to be used for specific mission planning. The appropriate aircraft Technical Order should be consulted when information is needed for this purpose. The data presented are, however, adequate for use in design or evaluation of airfield pavements.

SECTION II

EXPLANATION OF AIRCRAFT CHARACTERISTICS TABLES

1. AIRCRAFT (Col. 1, all tables). The basic mission symbol (bomber, fighter, cargo), design number, and series letter. The specific series chosen for each aircraft was based on the controlling dimension, gross weight, or performance data for the particular aircraft design number. (Ref. 2)

2. WING SPAN (Col. 2, Table I). The overall distance from wing tip to wing tip. (Ref. 1)

3. LENGTH (Col. 3, Table I). The overall distance from nose to tail, including radomes and antennae. (Ref. 1)

4. HEIGHT (Col. 4, Table I). The distance from ground level to the top of the vertical stabilizer. (Ref. 1)

5. TURNING RADIUS (Col. 5, Table I). The minimum radius of turn to keep all wheels (including outriggers) on the pavement. (Ref. 1, T.O.'s)

6. MAXIMUM TAKEOFF GROSS WEIGHT (Col. 6, Table II). Maximum normal or overload weight, whichever is greater. The normal weight represents the weight suitable for frequent use with adequate safety. The overload weight represents high risk operation at minimum load factor and performance criteria during takeoff. (Ref. 1)

7. BASIC MISSION TAKEOFF GROSS WEIGHT (Col. 7, Table II). The takeoff gross weight for the basic mission of the aircraft. The basic mission is generally specified such that similar aircraft may be compared as to mission capabilities. (Ref. 1)

8. BASIC WEIGHT (Col. 8, Table II). The empty weight plus trapped fuel and oil and all fixed armament and equipment for normal operation. (Ref. 1)

9. MAXIMUM LANDING GROSS WEIGHT (Col. 9, Table II). The greatest weight established for landing by individual Technical Order or design limitations. (Ref. 1)

10. LANDING WEIGHT (Col. 10, Table II). The landing gross weight used to compute landing performance (Cols. 13, 14). It is designated as the basic mission landing weight for bombers and fighters and the first landing weight for the basic mission for cargo aircraft. (Ref. 1)

11. TAKEOFF DISTANCE; GROUND ROLL (Col. 11, Table III). The ground roll required for the maximum takeoff gross weight (Col. 6), on a hard-surface runway at standard sea level with no wind. This is based on a lift-off speed of 110 percent of power-off stall speed, without ATO devices but with water-alcohol injection, where applicable. (Ref. 1)

12. TAKEOFF DISTANCE; TO CLEAR A 50-FOOT OBSTACLE (Col. 12, Table III). The horizontal distance required from brake release to clearance of a 50-foot obstacle, for the maximum takeoff gross weight, on a hard-surface runway at standard sea level with no wind. This is based on a speed of 120 percent of power-off stall at the point of clearance, without ATO devices but with water-alcohol injection, where applicable. (Ref. 1)

13. LANDING DISTANCE; GROUND ROLL (Col. 13, Table III). The landing ground roll required, for either the basic mission landing weight (bomber and fighter) or the first landing weight for the basic mission (cargo) on a hard-surface runway at standard sea level with no wind. Ground roll does not include the use of available auxiliary braking devices such as parabrakes and reverse thrust. (Ref. 1)

14. LANDING DISTANCE; TO CLEAR A 50-FOOT OBSTACLE (Col. 14, Table III). The ground distance required to land after clearing a 50-foot obstacle. This is based on landing weights of Col. 10, a hard-surface runway, standard sea level, and no wind. It does not include the use of available auxiliary landing devices. (Ref. 1)

15. TREAD (Col. 15, Table IV). The center-to-center distance between the main gear tires for single-wheel trucks or between the centroids of the main gear tires for multiple-wheel trucks. (Ref. 3)

16. WHEELBASE (Col. 16, Table IV). The center-to-center distance between the centroid of the main gear trucks and the nose (or tail) gear. (Ref. 3)

17. MAIN GEAR CONFIGURATION (Col. 17, Table IV). Either single (S), Twin (T), single-tandem (ST), twin-tandem (TW-TA), or twin-twin (TW-TW), as pictured in Figure 1.

18. MAIN GEAR TRUCK DISTANCE "C" (Col. 18, Table IV). As defined in Figure 1 for the truck configuration concerned. (Ref. 3)

19. MAIN GEAR TRUCK DISTANCE "D" (Col. 19, Table IV). As defined in Figure 1 for the truck configuration concerned. (Ref. 3)

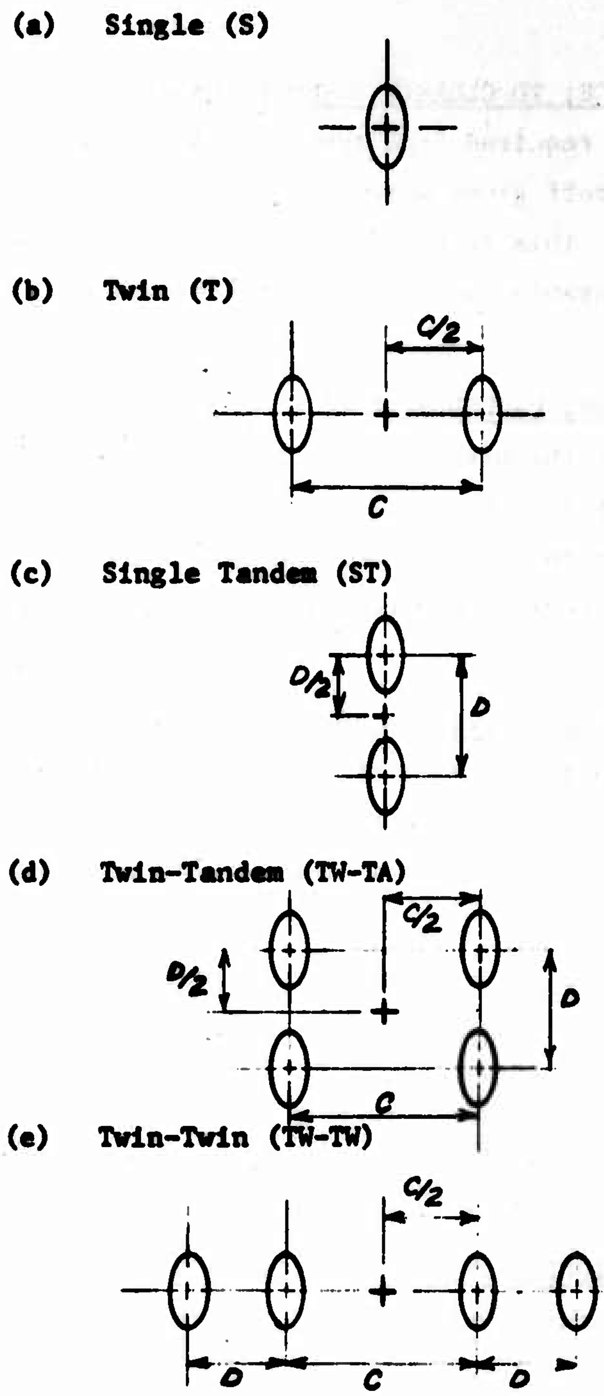


Figure 1. Landing Gear Truck Configurations
(+ indicates centroid of truck).

20. NOSE GEAR CONFIGURATION (Col. 20, Table IV). As presented in Figure 1.

21. NOSE GEAR DISTANCE "C" (Col. 21, Table IV). Same as for main gear. (Ref. 3)

22. MAXIMUM PERCENTAGE OF GROSS WEIGHT ON BOTH MAIN GEAR (Col. 22, Table V). A percentage based on allowable center of gravity (CG) limits for individual aircraft. For most aircraft this percentage occurs when the CG is at the limiting aft position. (Ref. 3)

23. MAXIMUM STATIC WHEEL LOAD (Col. 23, Table V). The maximum takeoff gross weight (Col. 6) multiplied by the maximum percentage of gross weight on both main gear trucks (Col. 22); this quantity then divided by the number of wheels on both main gear trucks (rear main gear for B-47 and B-52), or

$$\text{Maximum Static Wheel Load} = \frac{(\text{Col. 6}) \times (\text{Col. 22})}{\text{No. wheels on both main gear trucks}}$$

24. EQUIVALENT SINGLE-WHEEL LOAD (Col. 24, Table V). The load on a single wheel, of the same contact area as one wheel of a multiple wheel assembly, that produces a maximum deflection equal to that produced beneath the multiple wheel assembly. For this purpose the earth subgrade beneath the wheel load is assumed to be an elastic medium. A simplified procedure has been developed by the U.S. Army Waterways Experiment Station, Vicksburg, Mississippi for determining equivalent single-wheel load. This method is shown in Figure 2, and was used for data presented in Col. 24. (Ref. 4)

25. TIRE PRESSURE (Col. 25, Table V). The tire pressure for the maximum takeoff gross weight (Col. 6). (Ref. 3)

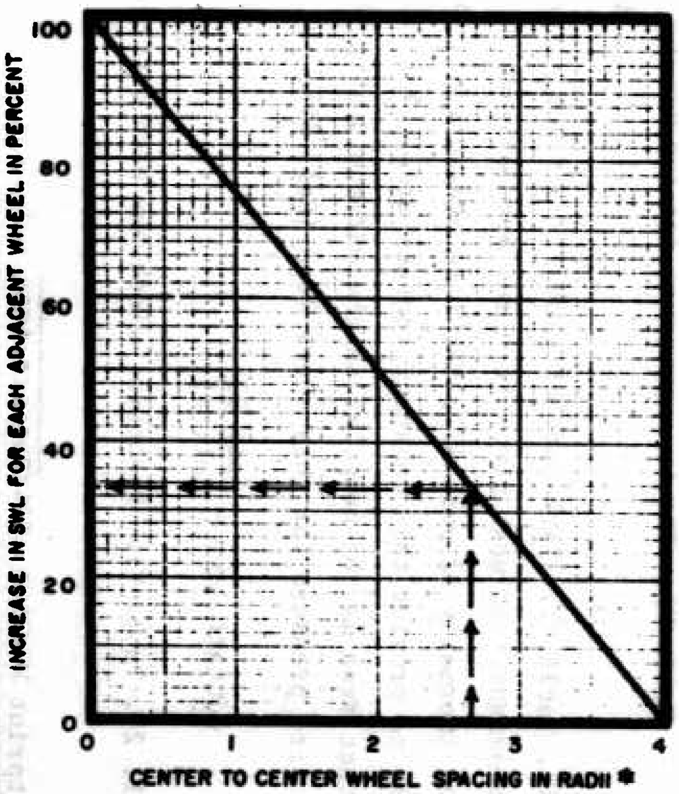
26. CONTACT AREA (Col. 26, Table V). Tire contact area for a fixed percentage of tire deflection is a constant. As most aircraft tires are designed for a fixed percentage tire deflection (normally 32 percent), the tire pressure must be varied with different wheel loads to provide this constant contact area. For the purposes of this report, tire contact area may be computed as the maximum static wheel load (Col. 23) divided by the tire pressure for this wheel load (Col. 25), or

$$\text{Contact Area} = \frac{\text{Col. 23}}{\text{Col. 25}}$$

27. FOOTPRINT WIDTH (Col. 27, Table V). Footprint width has been determined to be

$$\text{Footprint Width} = .874\sqrt{\text{Contact Area}}$$

which is based on an elliptical contact area having an aspect ratio of 1.6. (Ref. 4)



NOTE: * ANY WHEEL SPACED 4 RADII (CENTER TO CENTER) OR GREATER FROM A PARTICULAR WHEEL IS CONSIDERED TO HAVE NO EFFECT ON THE ESWL FOR THAT WHEEL.

** VALUES READ FROM CURVE AS INDICATED BY ARROWS.

PROCEDURE FOR DETERMINING THE ESWL FOR MULTIPLE-WHEEL ASSEMBLIES

ASSEMBLY LOAD = 100,000 LB

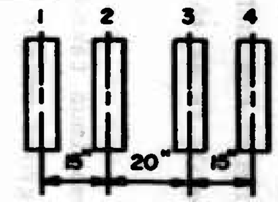
TIRE CONTACT AREA (A) = 100 IN.^{2}

SINGLE-WHEEL LOAD (SWL) = $\frac{\text{ASSEMBLY LOAD}}{\text{NO. OF WHEELS ON ASSEMBLY}}$

SWL = 25,000 LB

A = 100 IN^2 = πr^2

$r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{100}{\pi}} = 5.65$ IN.



TWIN-TWIN ASSEMBLY

DETERMINE EQUIVALENT SINGLE-WHEEL LOAD (ESWL) FOR WHEEL NO. 2

WHEEL NUMBER	CENTER TO CENTER SPACING INCHES	CENTER TO CENTER SPACING RADII	INCREASE IN SWL PERCENT
1	15	2.65	33.2 **
2			
3	20	3.54	11.5
4	35	6.19*	
		TOTAL	44.7

ESWL = 1.447 x SWL = 36,100 LB

UNLESS THE LOCATION OF THE MAXIMUM ESWL IS OBVIOUS, THE ESWL FOR EACH WHEEL OF THE ASSEMBLY AND AT THE CENTER OF THE ASSEMBLY WILL BE DETERMINED IN ORDER TO OBTAIN THE MAXIMUM ESWL FOR A GIVEN ASSEMBLY.

Figure 2. Procedure for Determining Equivalent Single-Wheel Load for Multiple-Wheel Assemblies (From WES).

28. <u>CYCLES PER COVERAGE</u> (Col. 28, Table V). Based on the formula

$$\frac{\text{Cycles}}{\text{Coverage}} = \frac{W}{TN\,(.75)}$$

where

Cycle = one takeoff and one landing

Coverage = sufficient passes of load tires in adjacent tire paths to cover a given width of pavement one time

N = maximum number of tires (not paths) which on any one pass of the airplane can be totally within the traffic lane. (Include nose gear tires only if load per tire is greater than 50 percent of the load per tire on the main gear).

T = one footprint width (inches) (Col. 27)

W = width of traffic lane. This width is dependent on the footprint width, lateral traffic distribution width*, and the c-c spacing of adjacent tire paths. The footprint width is defined above, and the lateral traffic distribution width has been determined to be 40 inches for channelized traffic and 80 inches for nonchannelized traffic (80 inches was used in computations for Col. 28). All adjacent tire paths that have c-c spacings less than 40 (or 80) inches plus T are to be considered in determining W. The width of the traffic lane is thus 40 (80) inches plus one footprint width, plus the c-c distance between the outermost tire paths being considered. (Ref. 4)

Example:

Aircraft: KC-135A

Gear is twin-tandem, so

N = 4

c-c spacing = 36 inches (Col. 18)

T = 13.3 inches (Col. 27)

Thus

W = 80 + 13.3 + 36 = 129.3 inches

and therefore

$$\frac{\text{Cycles}}{\text{Coverage}} = \frac{129.3}{(13.3)(4)(.75)} = 3.24$$

*Width within which the center lines of all aircraft tend to remain 75 percent of the time in traveling along a pavement.

TABLE I. DIMENSIONS

AIRCRAFT	WING SPAN	LENGTH	HEIGHT	TURNING RADIUS*
	ft	ft	ft	ft
(1)	(2)	(3)	(4)	(5)
Bomber				
B-26C	71.5	51.3	19.0	
B-47E	116.0	107.1	28.0	50.0
B-52H	185.0	157.6	40.7	114.0
B-57B	64.0	65.5	14.8	
B-58A	56.8	96.8	31.4	53.0
B-66B	72.5	75.2	23.6	29.0
Fighter				
F-86H	39.1	38.5	15.0	
F-89J	60.0	53.8	17.5	
F-100C	38.8	47.8	15.5	27.3
F-100F	38.8	52.5	16.2	27.3
F-101A	39.7	67.4	18.0	35.3
F-102A	38.1	68.3	21.2	24.4
F-104A	21.9	54.8	13.5	36.7
F-104C	21.9	54.8	13.5	36.7
F-105F	34.9	67.0	20.5	36.0
F-106B	38.3	70.7	20.3	25.3
F-111A	63.0	74.0	17.2	
F-4C	38.4	58.2	16.5	24.8
F-5A	28.6	47.2	13.2	23.7
Cargo				
C-47D	95.0	64.4	16.9	38.4
C-54G	117.5	93.8	27.5	40.0
C-97G(KC)	141.2	110.3	38.3	39.2
C-118A	117.5	106.8	29.1	39.4
C-119G	109.3	86.5	26.3	32.0
C-121G	123.0	116.2	24.8	53.0
C-123B	110.0	76.2	34.5	29.0
C-124C	174.1	130.0	48.6	42.0
C-130E	132.6	97.8	38.4	37.0
HC-130H	132.6	111.9	38.4	37.0
C-131E	105.3	79.2	28.1	29.0
C-133B	179.7	157.5	48.8	79.0
C-135A	130.8	134.5	41.7	65.0
KC-135A	130.8	136.2	38.3	65.0
C-140A	53.7	60.5	20.5	26.0
C-141A	160.7	145.0	39.3	54.0
C-142A	67.5	58.2	25.8	

* Minimum radius to keep all wheels on pavement.

TABLE II. GROSS WEIGHTS

AIRCRAFT	MAXIMUM TAKEOFF	BASIC MISSION TAKEOFF	BASIC WEIGHT	MAXIMUM LANDING	LANDING*
	Kips	Kips	Kips	Kips	Kips
(1)	(6)	(7)	(8)	(9)	(10)
Bomber					
B-26C	39.4	37.7	23.2	39.4	26.7
B-47E	230.0	226.0	81.0	180.0	94.0
B-52H	488.0	450.0	172.2	270.0	193.8
B-57B	57.0	53.7	28.8	42.0	31.5
B-58A	163.0	163.0	66.5	95.0	63.1
B-66B	83.0	83.0	43.5	83.0	49.5
Fighter					
F-86H	24.3	21.9	14.6	24.3	16.2
F-89J	47.7	45.6	27.0	40.3	31.7
F-100C	35.6	32.5	20.3	35.6	22.5
F-100F	37.8	34.7	22.2	35.0	24.5
F-101A	51.0	48.0	26.2	44.0	29.4
F-102A	31.3	28.2	19.5	28.2	22.1
F-104A	24.8	22.6	12.9	13.8	15.0
F-104C	27.9	22.4	13.2	16.0	15.2
F-105F	54.6	50.8	28.8	51.8	32.0
F-106B	39.6	35.2	24.9	36.8	28.0
F-111A					
F-4C	59.1	51.4	28.5	40.0	33.6
F-5A	19.9	19.1	8.6	19.9	10.9
Cargo					
C-47D	33.0	33.0	18.2	33.0	30.9
C-54G	73.0	73.0	39.4	73.0	67.8
C-97G (KC)	187.0	175.0	83.1	175.0	155.0
C-118A	129.4	122.0	59.1	108.0	108.0
C-119G	72.7	72.7	41.2	72.7	65.6
C-121G	145.0	134.4	75.1	122.0	120.8
C-123B	58.8	57.1	31.2	58.8	54.0
C-124C	216.4	216.4	103.0	194.5	191.7
C-130E	175.0	151.2	71.5	175.0	133.3
HC-130H	175.0	147.7	81.8	175.0	91.1
C-131E	60.5	55.9	33.4	50.7	51.2
C-133B	300.0	300.0	123.6	284.8	263.1
C-135A	277.5	255.9	100.1	230.0	214.9
KC-135A	300.8	300.8	99.1	222.0	207.7
C-140A	40.5	40.5	22.5	30.0	26.1
C-141A	316.6	266.0	136.3	316.1	235.8
C-142A	43.7	38.5	24.0	37.5	29.3

* Basic mission landing weight for bombers and fighters, first landing weight for basic mission for cargo aircraft.

TABLE III. PERFORMANCE*

AIRCRAFT	TAKEOFF DISTANCE GROUND ROLL	TAKEOFF DISTANCE CLR 50' OBST	LANDING DISTANCE GROUND ROLL	LANDING DISTANCE CLR 50' OBST
	ft	ft	ft	ft
(1)	(11)	(12)	(13)	(14)
Bomber				
B-26C	3840	4660	1430	2810
B-47E	10900	12550	4600	5500
B-52H	7420	9580	2370	4480
B-57B	5900	7300	2350	3100
B-58A	7850	13700	2615	5285
B-66B	6750	9350	3510	4830
Fighter				
F-86H	3130	4550	2950	3900
F-89J	4250	6300	2900	4050
F-100C	5575	7925	4080	5500
F-100F	4320	6120	3550	5050
F-101A	3800	5300	4210	5150
F-102A	2800	4390	2450	5100
F-104A	4825	7690	3160	5310
F-104C	5140	8400	3170	5320
F-105F	5450	7950	4600	6370
F-106B	3700	5540	4480	5900
F-111A				
F-4C	4200	5090	3060	4130
F-5A	6750	8150	3400	6000
Cargo				
C-47D	2900	5100	2040	3210
C-54G	2080	3925	1720	2940
C-97G (KC)	8400	10600	3390	4690
C-118A	5800	7500	2750	3710
C-119G	3180	5470	2235	2836
C-121G	4000	6300	2630	3730
C-123B	3030	4850	1550	2460
C-124C	5520	7380	3200	4525
C-130E	3600	5275	4150	5660
HC-130H	3170	4650	1840	2875
C-131E	3580	5150	1770	2650
C-133B	5040	5640	4385	6160
C-135A	8680	10270	3470	5205
KC-135A	9800	12340	3350	5025
C-140A	3670	5150	2050	2980
C-141A	3900	4830	1620	3480
C-142A	70	300	-	-

* For maximum takeoff and landing weights as shown in Cols. (6) and (10) respectively.

TABLE IV. LANDING GEAR CONFIGURATION*

AIRCRAFT	TREAD (A)	WHEELBASE (B)	GEAR TRUCK CONFIGURATION				
			MAIN			NOSE	
			TYPE	(C)	(D)	TYPE	(C)
	in	in		in	in		in
(1)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Bomber							
B-26C	234	161	S	-	-	S	-
B-47E	NA	436	T	37.0	-	NA	-
B-52H	NA	597	TW-TW	62.0	37.0	NA	-
B-57B	189	171	S	-	-	T	15.0
B-58A	160	488	TW-TA	26.5	26.5	T	14.0
B-66B	130	330	S	-	-	S	-
Fighter							
F-86H	100	196	S	-	-	S	-
F-89J	263	137	S	-	-	T	13.2
F-100C	149	176	S	-	-	T	7.3
F-100F	149	176	S	-	-	T	7.3
F-101A	239	256	S	-	-	T	9.5
F-102A	174	269	S	-	-	S	-
F-104A	106	181	S	-	-	S	-
F-104C	106	181	S	-	-	S	-
F-105F	208	285	S	-	-	S	-
F-106B	186	290	S	-	-	T	9.0
F-111A	120	293	S	-	-	T	15.0
F-4C	215	279	S	-	-	T	8.5
F-5A	133	185	S	-	-	S	-
Cargo							
C-47D	220	446	S	-	-	S	-
C-54G	296	329	T	29.0	-	S	-
C-97G (KC)	342	437	T	37.0	-	T	19.0
C-118A	296	434	T	30.7	-	S	-
C-119G	350	318	T	28.3	-	T	13.8
C-121G	336	523	T	33.0	-	T	30.0
C-123B	145	288	S	-	-	T	16.6
C-124C	410	357	T	44.0	-	T	27.0
C-130E	171	388	ST	-	60.0	T	22.0
HC-130H	171	388	ST	-	60.0	T	22.0
C-131E	300	314	T	26.0	-	T	20.0
C-133B	209	707	TW-TA	31.8	76.5	T	27.0
C-135A	265	548	TW-TA	36.0	60.0	T	22.3
KC-135A	265	548	TW-TA	36.0	60.0	T	22.3
C-140A	148	248	T	14.5	-	T	10.6
C-141A	210	636	TW-TA	32.5	48.0	T	21.0
C-142A	201	251	T	13.3	-	T	18.0

*See Figure 1 for explanation of symbols.

TABLE V. PAVEMENT DESIGN (EVALUATION) DATA

AIRCRAFT	MAXIMUM % WEIGHT MAIN GEAR	MAXIMUM STATIC WHEEL LOAD	EQUIVALENT SINGLE WHEEL LOAD	TIRE PRESSURE	CONTACT AREA	FOOT-PRINT WIDTH	CYLES PER COVERAGE
	%	Kips	Kips	PSI	SQ. IN.	IN.	
(1)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
Bomber							
B-26C	84.7	16.7	16.7	70	238	13.5	9.25
B-47E	56.2*	64.6	66.3	230	280	14.6	2.25
B-52H	55.0*	67.1	67.1	285	236	13.4	2.85
B-57B	94.2	26.9	26.9	150	180	11.7	10.45
B-58A	95.7	19.5	19.5	270	72	7.4	5.13
B-66B	86.2	35.8	35.8	128	279	14.6	8.64
Fighter							
F-86H	93.4	11.3	11.3	180	63	6.9	16.80
F-89J	81.0	19.3	19.3	225	86	8.1	14.50
F-100C	91.9	16.4	16.4	265	62	6.9	16.80
F-100F	89.5	16.9	16.9	270	63	6.9	16.80
F-101A	88.8	22.7	22.7	290	78	7.7	15.20
F-102A	90.0	14.1	14.1	225	63	6.9	16.80
F-104A	91.2	11.3	11.3	247	46	5.9	19.40
F-104C	91.5	12.8	12.8	272	47	6.0	19.22
F-105F	85.8	23.4	23.4	220	106	9.0	13.19
F-106B	91.4	18.1	18.1	285	63	6.9	16.80
111A		36.8	36.8	150	244	13.6	9.18
F-4C	87.8	26.0	26.0	255	102	8.8	13.45
F-5A	86.2	8.6	8.6	210	41	5.6	20.35
Cargo							
C-47D	95.7	15.8	15.8	60	263	14.2	8.85
C-54G	93.5	17.1	18.8	77	222	13.0	6.25
C-97G(KC)	95.0	44.5	44.5	180	247	13.8	6.31
C-118A	97.0	31.4	36.0	124	252	13.9	5.97
C-119G	90.0	16.4	18.4	80	205	12.5	6.43
C-121G	95.5	34.6	38.2	130	266	14.3	5.94
C-123B	83.8	24.6	24.6	90	274	14.5	8.69
C-124C	93.4	50.6	62.2	79	640	22.1	4.29
C-130E	95.7	41.9	41.9	95	440	18.3	3.60
HC-130H	95.7	41.9	41.9	115	364	16.7	3.86
C-131E	96.9	14.7	16.1	90	163	11.2	7.00
C-133B	96.7	36.3	45.9	98	370	16.8	2.55
C-135A	95.1	33.0	33.0	143	230	13.3	3.24
KC-135A	94.3	35.5	35.5	155	230	13.3	3.24
C-140A	86.3	8.8	9.0	205	43	5.7	11.72
C-141A	94.4	37.4	37.4	180	208	12.6	3.32
C-142A	81.9	8.9	14.1	45	200	12.4	5.67

*Rear truck for B-47 and B-52.

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13. ABSTRACT

Aircraft characteristics data are presented for use by civil engineers in the layout,design, and evaluation of airfield pavement systems. Aircraft dimensions, pertinent gross weights and performance data, and landing gear configurations are presented in convenient reference tables.

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19 April 1966

ERRATA

AFWL-TR-65-206 AIRCRAFT CHARACTERISTICS FOR AIRFIELD PAVEMENT DESIGN AND EVALUATION

Page 6: Add the following note to Figure 2:

An equivalent single wheel load graph is for unsurfaced or membrane surfaced soils. The procedure for determining equivalent single wheel loads for standard flexible pavement systems is found in Waterways Experiment Station Instruction Report #4 entitled "Developing a Set of CBR Design Curves," November 1959.

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